

1st European Seminar on Supercritical CO₂ (sCO₂) Power Systems



29.-30. September 2016 - Vienna - Austria



TECHNISCHE
UNIVERSITÄT
DRESDEN



University of Stuttgart
Germany

SEMINAR PROGRAM

SCIENTIFIC TOPICS



UNIVERSITÄT
DUISBURG
ESSEN

Open-Minded

TURBO MACHINERY
CSP AND NUCLEAR APPLICATIONS
HEAT TRANSFER AND HEAT EXCHANGER TECHNOLOGY

STORAGE SYSTEMS BASED ON sCO₂
EXPERIMENTAL sCO₂ SYSTEMS
POWER CYCLE ANALYSIS

Wednesday - 28.th September 2016

09:00am-05:00pm **WORKSHOP: sCO₂ Turbines Fundamentals – Cycles, Turbine Design & Analysis, Blading**

Thursday - 29.th September 2016

09:00am **Registration at the conference-office**

10:00am **Seminar Opening and Plenary Session** Chair: Markus Haider

Location: Festsaal, Technische Universität Wien, Karlsplatz 13, 1040 Wien

10:10am **Plenary Session**

An overview of sCO₂ related R&D activities at Southwest Research Institute

Klaus Brun, Southwest Research Institute, United States of America

10:55am **Plenary Session**

The criticality of CO₂ and materials for CSP

Wesley Harold Stein, CSIRO Energy Australia

11:40am **Plenary Session**

sCO₂ Power Cycle Commercialization for Heat Recovery Applications

Timothy Held Echogen

12:30pm **Lunch Break**

01:30pm **TRACK 1 Presentations**

Location: Festsaal, Technische Universität Wien, Karlsplatz 13, 1040 Wien

01:30pm **The supercritical CO₂ heat removal system – sCO₂-HeRo**

F.-K. Benra; D. Brillert; O. Frybort; P. Hajek; M. Rohde; S. Schuster; M. Seewald; J. Starflinger

Presenter: A. Hacks

Univ. of Duisburg-Essen, Centrum výzkumu Řež; ÚJV Řež; Delft Univ. of Technology, Kraftwerks-Simulator-Ges.mbH (KSG), Ges. für Simulatorschulung mbH (GfS) - The simulation center; Univ. of Stuttgart

02:00pm **Inclusion of CO₂ Transcritical Heat-Pump and Power Cycles in a Massive Electricity Storage System**

F. Ayachi; N. Tauveron; T. Tartiere; D. Nguyen; H. Davarzani; E. Macchi

CEA; Enertime; BRGM; Université de Toulouse, France

02:30pm **Design and operation of a pilot scale super critical CO₂ system by concentrated solar power**

W. H. Stein; R. McNaughtona; W. Gardnera; Jin-Soo Kima; D. Pottera; CSIRO Energy Australia

03:00pm **Design, Construction and Start-Up of a Test Facility for Experimental Investigations Flow and Heat Transfer with Supercritical CO₂**

W. Flaig; R. Mertz; J. Starflinger; Universität Stuttgart, Institut f. Kernenergetik und Energiesysteme, Germany

03:30pm **Coffee Break**

03:45pm **TRACK 1 Presentations**

Location: Festsaal, Technische Universität Wien, Karlsplatz 13, 1040 Wien

03:45pm **Supercritical CO₂ (sCO₂) as alternative working fluid for a wide range of operating temperature – turbo machinery design aspects**

U. Gampe; M. Raddatz; J. Lückert; G. Buchheim

TU Dresden, Institute of Power Engineering, Chair of Thermal Power Machinery and Plants Germany

04:15pm **Dynamic simulation of two concentrated solar power concepts with supercritical CO₂ Brayton cycle**

E. Hakkarainen; T. Sihvonen; J. Lappalainen; VTT Technical Research Centre of Finland Ltd., Finland

04:45pm **Materials and Manufacturing Challenges for Compact Heat Exchangers of Supercritical CO₂ Power Systems**

M. Kapoor; O. N. Dogan; R. V. Saranam; B. K. Paul

U.S. Department of Energy, National Energy Technology Laboratory, Oregon State University, USA

05:15pm **CSP-Systems based on sCO₂-Power Cycles and Particle based Heat Storage**

P. Steiner; K. Schwaiger; M. Haider; TU, Wien, Institute for Energy Systems and Thermodynamics

07:00pm **CONFERENCE DINNER**

Thursday - 29.th September 2016

01:30am TRACK 2 Presentations

Location: Böcklsaal, Technische Universität Wien, Karlsplatz 13, 1040 Wien

01:30pm Comparison of Conventional and CO₂ Power Generation Cycles for Waste Heat Recovery

A. Werner; G. Klemencic; F. Stylianos; H. Leibinger; M. Haider

TU, Wien, Institute for Energy Systems and Thermodynamics

02:00pm Analysis of Transcritical and Supercritical CO₂ Power Cycle for Applicability in Waste Heat Recovery

M. V. Rajeshbhai; D. P. Bharatkumar; P. C. Hargovindbhai; A. S. Bhasuru

Pandit Deendayal Petroleum University, India

02:30pm Waste heat recovery

M. de Miol; A. Leroux; S. Tassou; Y. Ge

ENOGIA, France

03:30pm Coffee Break

07:00pm CONFERENCE DINNER

Friday - 30.th September 2016

09:00am TRACK 1 Presentations

Location: Festsaal, Technische Universität Wien, Karlsplatz 13, 1040 Wien

09:00am Experimental investigation of heat transfer to supercritical organic fluid R125 in horizontal tubes for Organic Rankine Cycle applications.

M. Lazova; T. Stepman; A. Kaya; H. Huisseune; M. DePaepe

Ghent University, Belgium

09:30am Thermoelectric energy storage based on CO₂ transcritical cycles: ground heat storage modelling

E. G. Macchi; C. Colin; T. Tartière; D. Nguyen; N. Tauveron

Institut de Mécanique des Fluides, Université de Toulouse; Enertim; BRGM Languedoc-Roussillon; CEA, LITEN – DTBH/SBRT/LS2T, France

10:00am Supercritical CO₂ Brayton cycles coupled with linear receivers in concentrated solar power plants

L. Moretti; M. Binotti; G. Manzolini; Politecnico di Milano, Italy

10:30am Power cycle calculations and preliminary design of a compact heat exchanger of a scaled down sCO₂-HeRo-system for a PWR glass model at KSG/GfS.

M. Strätz; R. Mertz; J. Starflinger

Universität Stuttgart - Institut für Kernenergetik und Energiesysteme IKE, Germany

11:00am Coffee Break

11:15am TRACK 1 Presentations

Location: Festsaal, Technische Universität Wien, Karlsplatz 13, 1040 Wien

11:15am Development of a Small-Scale Supercritical CO₂ Turbine Power System

J.-M. Char; Fooyin University, Taiwan, Republic of China

11:45am Supercritical CO₂ heat removal system - integration into European PWR fleet

A. Vojacek; V. Hakl; P. Hajek; Research Centre Rez, Czech Republic

12:15pm Lunch Break

01:15pm TRACK 1 Presentations

Location: Festsaal, Technische Universität Wien, Karlsplatz 13, 1040 Wien

01:15pm Improvement of heat transfer and fluid flow model for supercritical CO₂

S. Pandey; E. Laurien; X. Chu

Institute of Nuclear Technology and Energy Systems (IKE), University of Stuttgart, Germany

01:45pm Conference End

Friday - 30.th September 2016

09:00am TRACK 2 Presentations

Location: Böcklsaal, Technische Universität Wien, Karlsplatz 13, 1040 Wien

09:00am **Development of an experimental S-CO₂ loop for bottoming cycle applications**

E. Anselmi; P. Zachos; R. Collins; M. Hassan

Cranfield University, Rolls-Royce plc, United Kingdom

09:30am **Parametric evaluation of S-CO₂ Brayton cycles for bottoming applications**

G. Brighenti; E. Anselmi; Cranfield University, United Kingdom

10:00am **The Research of S-CO₂ cycles at CTU in Prague**

L. Vesely; V. Dostal; M. Soukupova

Czech Technical University in Prague, Czech Republic

10:30am **Analysis of the Advantages of Supercritical Power CO₂ CYCLES**

P. Hájek

UJV Rez, Czech Republic

11:00am Coffee Break

11:15am TRACK 2 Presentations

Location: Böcklsaal, Technische Universität Wien, Karlsplatz 13, 1040 Wien

11:15am **Design Analysis of the Allam Cycle**

M. Penkuhn; G. Tsatsaronis

Technische Universität Berlin, Germany

11:45am **An Overview of the sCO₂-test rig Project at TU Wien**

G. Klemencic; A. Werner; M. Haider

TU, Wien, Institute for Energy Systems and Thermodynamics

12:15pm Lunch Break

01:15pm TRACK 2 Presentations

Location: Böcklsaal, Technische Universität Wien, Karlsplatz 13, 1040 Wien

01:15pm **Off-design steady-state performance assessment of supercritical CO₂ Brayton cycle for coal-fired power plants**

M. Mecheri

EDF, France

01:45pm **Study of a tri-generation system based on a supercritical CO₂ cycle**

T. Morosuk; L. Morozuk; S. Gayduk; B. Hrudka, G. Tsatsaronis

Technical University Berlin, Germany; Odessa National Academy of Food Technologies, Ukraine

02:30pm Conference End